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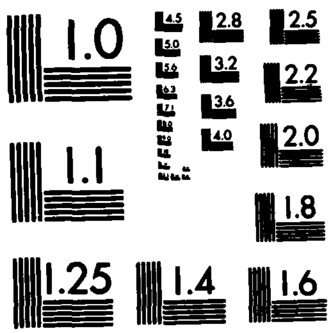

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A CASE STUDY OF THE F-16 MINI-BLOCK CONFIGURATION MANAGEMENT CONCEPT

Susan A. Goodrich, Captain, USAF
Nancy J. Hackmeier, First Lieutenant, USAF

LSSR 25-82

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Heightened interest in life cycle costs of weapon systems has caused increased emphasis to be placed on contract correction of deficiency (COD) clauses. It is important to include design changes relative to these deficiencies as early as possible in production of systems while not fostering nonstandard configurations. Therefore, standard "break-in" points for the incorporation of COD engineering change proposals (ECPs) are required. In the F-16 Air Combat Fighter program these break-in points are called "mini-blocks" and are used to minimize retrofit changes and accommodate early production inclusion. Presently mini-blocks include approximately thirty aircraft. However, the optimal size of mini-blocks remains in question. This thesis examined mini-blocks of various sizes in an attempt to determine optimal size, considering the impact of retrofit labor costs, and to determine the availability of updated technical orders and support equipment. Upon completion of the research, the authors concluded that, from a retrofit labor cost standpoint, there is no evidence that mini-block size should not be increased. Also, the inception of the mini-block concept did increase supportability of the F-16 aircraft in the area of updated technical orders. The study confirmed the hypothesis that use of mini-blocks provided a more orderly incorporation of COD ECPs.

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A CASE STUDY OF THE F-16 MINI-BLOCK CONFIGURATION MANAGEMENT CONCEPT

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

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September 1982

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This thesis, written by

Captain Susan A. Goodrich

and

First Lieutenant Nancy J. Hackmeier

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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COMMITTEE CHAIRMAN

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CHAPTER I

THE RESEARCH PROBLEM

Introduction

Concern continues to grow within the Department of Defense and the Congress over the increasing cost of producing new weapon systems for our defense arsenal (8:1). While development and procurement costs gain the most attention (because these costs and their associated schedules, responsibilities, and performance requirements are usually well defined), these costs may not be the most significant. The life cycle cost (LCC) of supporting and maintaining the weapon system may exceed the development and procurement costs many times over.

Controlling the LCC of a system has become a major issue as the complexity and sophistication of weapon systems increase. Designing LCC parameters that maintain a high level of contractor interest in the weapon system following delivery has become paramount. Air Force Regulation (AFR) 800-11 defines LCC as ". . . the total cost of an item or system over its full life [18:3]." LCC then includes the cost of development, acquisition, ownership, and disposal.

> LCC necessitates an integrated approach to determining the total impact of a decision--the total integration of engineering, logistics, procurement, comptroller, and the program office in order to bring to bear upon the problem the forces that are needed to make the "best" decision [18:3].

The contracting process must motivate the contractor in such a way that LCC becomes a dominant objective (18:3-6). The contractor must be held responsible and accountable for weapon system performance. Thus, explicit correction of deficiency (COD) clauses have become prominent elements for LCC control (3:1).

Defense Acquisition Regulation (DAR) 7-105.7c states the objective of COD clauses as the correction of design deficiencies after the delivery and acceptance of a product or weapon system (8:5). The contractor is held responsible for any redesign necessary to satisfy contractual performance requirements or criteria. Corrective action includes not only the design effort, but the materials and workmanship necessary to correct the deficiency. Coverage is normally extended to field performance and generally includes the initial six to twelve month period following delivery of the product or weapon system. This time period may be changed if agreed upon by both the government and the contractor. The provisions in the COD clause cover contractor-caused deficiencies discovered by the System Program Office (SPO), the user, or the contractor (1:91).

Conformance to performance specifications determines whether or not the contractor has actually corrected the deficiency as determined by government inspectors (1:89). The overall objective of COD action is to repair, rework, or replace delivered items that do not meet contractual performance requirements.

There are both advantages and disadvantages in using a COD clause within a contract. The advantages are: (1) the clause allows no cost for firm-fixed price (FFP) contracts, but it does allow for shared costs up to some ceiling amount on incentive contracts; (2) cost accountability is not required on FFP contracts; (3) COD clauses appear to be relatively simple to administer since measurement parameters, the conformance to performance specifications, are usually clearly defined (8:5). However, the disadvantages making the COD clause difficult to invoke are: (1) coverage by the COD clause is limited to design deficiencies only; (2) the government is totally responsible for proving that the alleged deficiencies are truly caused by inadequate design (8:5-6).

In correcting deficiencies, especially where safety is a concern, it is important to incorporate changes as early as possible in production. However, each time a change takes place, the configuration of the product essentially changes. Over a period of time, the configuration may become nonstandard. As a result, it becomes difficult to maintain technical orders and support equipment in the appropriate configuration (4). For this reason, it is important to use standard "break-in" points for the incorporation of COD engineering change proposals (ECP) during production by implementing "mini-blocks." The objective of the mini-block is

> . . . to minimize retrofit type changes by predetermining the production break-in points within the major block and incorporating these changes at a common point in production [4].

The mini-block program addressed in this effort was designed for use in the F-16 Air Combat Fighter (ACF) program which is a multinational coproduction effort between the countries of Belgium, The Netherlands, Denmark, Norway, and the United States. Each of these countries takes part in the production and assembly of the F-16 making it one of the largest coproduction programs ever (16:pp.10-1 to 10-4). Aircraft under production are divided first into major blocks. The major block break-in points are used to control major configuration changes in the form of improvement ECPs (20:1). The major block break-in points are managed by the SPO to insure that each major block of aircraft receives the modifications necessary to maintain a standard configuration. The mini-block concept provides for the control and timely incorporation of lesser improvements, usually in the form of COD changes (20:1). Several mini-blocks may be established within the time frame of the major block. The mini-blocks function as an internal control and auditing system for both General Dynamics, the prime contractor for the F-16, and the SPO. The mini-block concept gives the contractor and the SPO an internal method to incorporate, track, and monitor COD changes since the mini-block is a predetermined production break-in point within the major block.

Problem Statement

In June 1981, concern was voiced that the intent of the mini-block concept had strayed (20:1). Headquarters Tactical Air Command (Hq TAC) was concerned that the proliferation of mini-blocks within the F-16 program exceeded both the original intent and requirements. The original intent of Hq TAC was for mini-blocks of 90 to 100 aircraft. However, the average mini-block thus far had consisted of less than 30 aircraft. While the configuration of the F-16 aircraft is being controlled through the use of mini-blocks, the optimal size of the mini-blocks remains in question. This thesis therefore examined mini-blocks of various sizes and the associated impacts, if any, in the areas of technical orders and support equipment. It also examined whether or not the mini-block concept has decreased the delivery delays in the area of technical orders.

The mini-block sizes investigated in this study included:

1. the present mini-block size of two months of production (approximately 27 aircraft);

2. the mini-block size of four months of production (approximately 50 aircraft);

3. the mini-block size of six months of production (approximately 75 aircraft); and

4. the mini-block size of eight months of production (approximately 100 aircraft) (6:1).

Justification for and Purpose of the Research

The mini-block concept is relatively new and was first proposed for use in the F-16 program as of February 1980 (4). While major blocks and mini-blocks were incorporated in the F-15 and F-14 programs, and major blocks were used in the A-10 program, there is little correlation to the F-16 mini-block concept (13:2). General Dynamics conducted the only study to determine the optimal mini-block size. No study, however, has been accomplished determining the overall effectiveness of the mini-block concept in providing the modified technical orders concurrently with the modified F-16 aircraft.

Therefore, the purpose of this research effort is to (1) determine the effectiveness of the mini-block concept in providing the updated technical orders concurrently with the modified F-16 aircraft, and (2) to determine the optimal mini-block size considering the impact of retrofit labor costs and any impacts on the availability of the modified technical orders and support equipment.

Research Hypotheses

1. Since the incorporation of the mini-block concept in the F-16 program, the mean time between the planned delivery date for the modified technical orders and the actual delivery date has decreased (level of significance equal to 0.05).

2. The optimal mini-block size considering the retrofit labor costs and any associated impacts on the availability of the modified technical orders and support equipment will remain at the present size of two months.

Scope of the Research

This study dealt with the mini-block concept within the F-16 program with major emphasis on finding the optimal mini-block size considering retrofit labor costs. Special attention was given to determining what impacts, if any, the mini-block concept has had in the areas of modified technical orders and support equipment.

Assumptions

The correspondence, briefings, and interviews of F-16 personnel provided an accurate accounting of the F-16 mini-block concept.

Limitations

1. This study addressed only the blocks and mini-blocks incorporating changes within the USAF F-16 aircraft.

2. The COD ECPs with retrofit addressed within the mini-block concept may have been implemented by General Dynamics prior to their negotiation as a result of an agreement between the F-16 Directorate of Contracting and General Dynamics. If this agreement was terminated or altered, the research results may have differed.

3. This study addressed only the F-16 program. If a different major acquisition program was addressed, the research results could differ greatly.

4. This study addressed only organizational and intermediate (O&I) level support equipment.

5. This study addressed only those COD ECPs with retrofit. These ECPs were used to show the costs, in terms of additional retrofit labor, incurred by delaying production incorporation of the COD ECPs.

General Research Plan

The first research hypothesis addressed the mean time between the planned delivery date for the modified technical orders and the actual delivery date. It was hypothesized that this mean time had decreased upon the incorporation of the mini-block concept (level of significance equal to 0.05). A random sample of 42 data points from the pre mini-block time frame (Blocks 1 and 5) and the post mini-block time frame (Blocks 10 and 15, including the mini-blocks) was gathered. The data came from the F-16 Directorate of Configuration Management's Status Accounting system. The equality of variances, F test, was conducted to determine whether the parametric independent sample t-test should have been used to analyze the data, or if the nonparametric Mann-Whitney Wilcoxon test should have been used (12:263). The test results indicated whether or not the mini-block concept had indeed decreased the difference between the planned delivery (or need date) and the actual delivery date of the modified technical orders.

The second research hypothesis addressing the optimal mini-block size considering the retrofit costs and any associated impacts on the availability of the modified technical orders and support equipment was resolved using a quantitative study of the financial impact of retrofit labor costs on various mini-block sizes. This quantitative study was combined with interviews of F-16 SPO personnel in the areas of technical orders and support equipment to determine the impact, if any, of various mini-block sizes on those areas. The data for the quantitative study was provided by the F-16A/B Block Configuration Report as of 1 March 1982 (2). Each applicable COD ECP with retrofit was then researched in the F-16 Directorate of Configuration Management's files. The basis for this analysis was the COD ECPs with retrofit that had been scheduled for incorporation with the present mini-block schedule through Block 15K. From this data source, a projection of the increased costs, in terms of retrofit labor, of various mini-block sizes was made. This projection showed the costs incurred by delaying the production incorporation of the COD ECPs with retrofit and thus having to retrofit additional F-16 aircraft.

CHAPTER II

BACKGROUND AND LITERATURE REVIEW

Overview

The mini-block concept is relatively new. The concept was first proposed for use in the F-16 program as of February 1980 (4). The mini-block concept is a predetermined production break-in point for COD ECPs. Questions had been raised as to the optimal mini-block size. General Dynamics, the F-16 prime contractor, completed a study recommending that the present mini-block size of two months/27 aircraft be maintained. However, Headquarters, United States Air Force (Hq USAF) requested the F-16 SPO to consider mini-blocks of at least four months/54 aircraft. The following section on the background and literature discusses the development of the COD ECP provision in the F-16 program and the incorporation of the mini-block concept.

Background and Literature Review

The initial set of LCC provisions included in the F-16 Request for Proposal (RFP) contained the COD requirement (14:1). The COD provision was included in recognition of the highly competitive nature of the proposal between Northrup and General Dynamics for the F-16. When the contractors first submitted COD proposals, several problems became apparent. The contractors had failed to respond to the COD requirement required by the proposal instructions. They seemed reluctant to depart from past practices where deficiencies were concerned. The proposals were not properly priced because the contractors were uncertain of the risks associated with the COD clause. Overall, there appeared to be a general lack of understanding of the COD provision (3:3).

To remedy this situation, a clarification briefing was held on 15 November 1974 (3:4). For COD bidding to be competitive the contending contractors needed a complete understanding of any risks associated with the COD provision. The F-16 Program Manager, at that time, emphasized the failure of any of the bidding contractors to provide a responsible bid on the COD provision would be viewed as a serious deficiency during the proposal evaluation (3:4). The overall point of the clarification briefing was to clearly explain the government's objectives in the COD cost-control program and the contractor's requirements and obligations.

When the final responses were received by the government, General Dynamics was the only prime contractor to submit a responsible and responsive bid concerning COD provisions (3:5). However, General Dynamics had deleted the radar first line units because the radar was being developed under a separate Air Force contract. General Dynamics believed it lacked the appropriate authority and detailed design data to make a responsible bid (3:5). This problem was remedied in a subsequent written agreement between the government and the contractors to include COD proposals from the radar contractors and to pass the bid price on to the Air Force with a predetermined mark-up.

General Dynamics' final COD price offer was $6,921,000 (3:6). This price was approximately 54 percent lower than an earlier General Dynamics offer. The price reduction was brought about by a General Dynamics proposal to reduce the total COD price by $4 million if the Air Force agreed to a 15 percent no-fault range above the Target Logistic Support Cost (TLSC) (3:6).

Although the F-16 contract with General Dynamics-Fort Worth Division (F33657-75-C-0310) states

> . . . in the event the total Measured Logistic Support Cost (MLSC) exceeds the total TLSC-COD, by more than 25 percent, the contractor must institute a correction of deficiencies (COD) course of action which will bring the logistics cost within the prescribed range [and] this proposed course of action must be submitted to the Government for review and approval prior to implementation [3:E-35],

the F-16 Directorate of Contracting and General Dynamics developed an alternate procedure by mutual agreement (5:1). This procedure was developed

> . . . to expedite the definitization and subsequent contractual authorization of required contract changes whose value is less than $250,000 and whose

> required implementation time is less than six (6) months subsequent to proposal submitted [14:27].

The procedure calls for General Dynamics to submit a firm proposal to the F-16 SPO allowing for timely telephone negotiations of the task. "In turn, General Dynamics has agreed to start work, at their own risk, upon receipt of a [ASD/] YPK confirmation of negotiation letter [14:2]." While the F-16 contracting personnel approved of this agreement allowing General Dynamics to begin corrective action immediately once a deficiency was uncovered, the approach created a multitude of problems for the configuration personnel (5:2). The approach resulted in many small COD ECPs being incorporated as soon as the material to do so became available. Thus, the first 43 production F-16s were manufactured in nearly as many different configurations (21:7). This created tremendous logistics support problems for maintenance and supply technicians, the SPO, and General Dynamics.

The mini-block concept, proposed in February 1980, involved three major areas of corrective action for this problem (14:2). First, the concept placed all future COD actions into the mini-block system. Second, the Air Force and Israeli mini-blocks were set up in two month intervals involving 30 to 38 aircraft (7). Third, the European participating government (EPG) aircraft were divided into four month intervals with twelve aircraft from each manufacturing line, Sabca, Fokker, and General Dynamics. These mini-block intervals were designed to ensure an orderly break-in of COD ECP changes so multiple retrofit kit configurations are minimized (13:1). The mini-block concept enhances the planning capability of both the contractor and the SPO. The SPO functioned under these guidelines until January 1981 (7). At that time, increased emphasis was placed on having the technical orders, spares, and support equipment available with each aircraft. Headquarters Tactical Air Command (Hq TAC) pointed out that although the aircraft configuration was being controlled, the associated changes in modified technical orders, spares, and support equipment were frequently not simultaneously available (20:1). There was also the problem of having multiple configurations of the F-16 at the same location.

Therefore, General Dynamics was requested by the F-16 SPO to complete a study of desirable mini-block sizes (6:2). General Dynamics was requested to do the study since the mini-block point for the break-in of production changes is set by its Configuration Change Board (CCB). The General Dynamics study recommended maintaining the present mini-block size of two months/27 aircraft. Increasing the two month mini-block size could

> . . . possibly result in more aircraft of a single configuration at a specific site. However, there is a very high probability that the desire to periodically

> accelerate selected high priority changes would result in breaking in more changes between mini-blocks. This would result in compromising the entire mini-block concept [15:1].

The results of the General Dynamics study were briefed on 24 June 1981 (4). Hq TAC was notified of the F-16 SPO's decision to continue with the two month mini-block intervals on 20 October 1981 (15:3). Headquarters, Air Force Systems Command (Hq AFSC) concurred with the F-16 SPO's decision (19:1). However, on 9 February 1982, Headquarters, United States Air Force (Hq USAF) requested the F-16 SPO to consider enlarging the mini-blocks to at least four months of production/54 aircraft (21:7).

The request by Hq USAF was based on the fact that "the volume of ECPs is steadily reducing as the F-16 matures [21:7]." If the size of the mini-block was enlarged, then the F-16s sent to new locations would be of a single configuration (21:7).

> The 27-30 aircraft mini-block plan should be the fallback position to be used only when safety or overriding costs dictate that engineering changes be incorporated as soon as possible. As a matter of course, mini-blocks need to be enlarged to at least four months of production (54 aircraft) or more whenever possible. Larger mini-blocks will reduce logistics costs and also reduce the exposure of our maintenance technicians to potential errors which result in installing the wrong part in the wrong mini-block aircraft [21:7].

The F-16 mini-block concept was compared with the F-15 and A-10 "block" programs (13:2). The F-16 mini-block concept was also compared with the Navy F-14 "block" concept (11). There was little correlation to the F-16 mini-block concept. The F-15 "blocks" and the A-10 "options" referred to the fiscal year buys, not to the orderly incorporation of COD ECPs. While the F-16 blocks are primarily managed by configuration personnel, the F-15 "blocks" and the A-10 "options" were controlled by the contractor, SPO contracting, and SPO manufacturing. Furthermore, some planning took place when identifying the F-15 "blocks" and A-10 "options," but planning was not the driving consideration as in the case of the F-16. Nor did the A-10 program include mini-blocks or COD ECPs. The F-14 blocks were driven solely by the annual production rate. Therefore, the F-16 mini-block and block concepts are truly unique methods of incorporating COD ECPs and improvement ECPs.

Synopsis

The F-16 mini-block concept was developed in response to the tremendous logistics support problems resulting from many small COD ECPs being incorporated on the F-16 aircraft as soon as the material to do so became available. General Dynamics and the SPO believe that the present mini-block size of two months/27 aircraft should be maintained. They fear that selected high priority changes would be accelerated thus breaking in more changes between mini-blocks. This would compromise the integrity of the mini-block concept.

On the other hand, Hq TAC and Hq USAF believe that the mini-block size should be enlarged. This would result in the F-16s sent to new locations being of a single configuration. The larger mini-blocks, in their opinion, would reduce not only the logistics costs, but the possibility of errors by maintenance technicians. Thus, there is a standoff between the two positions.

The F-16 mini-block concept is unique with the major objective being the orderly incorporation of COD ECPs. Unlike the F-15 and F-14 "block" programs and the A-10 "option" program, planning enhancement is the driving consideration behind the F-16 mini-block program.

CHAPTER III

RESEARCH METHODOLOGY

Introduction

This research effort dealt with two areas, the first being the determination of whether the mean time between the planned delivery date for the modified technical orders and the actual delivery date has decreased since the incorporation of the mini-block concept in the F-16 program. While the spares and support equipment deliveries are also an issue, the data to complete such a study were unavailable. The second area dealt with estimating the optimal mini-block size for the Air Force considering the retrofit labor costs and any associated impacts on the availability of the modified technical orders and support equipment. The data supporting both of these efforts came from the F-16 SPO.

Research Design

The first research hypothesis stated: since the incorporation of the mini-block concept in the F-16 program, the mean time between the planned delivery date (or need date) for the modified technical orders and the actual delivery date has decreased (level of significance equal to 0.05). This showed whether the mini-block concept had indeed increased supportability. A random sample of size 42 was gathered for the combined pre mini-block and post mini-block time frames. The data came from the F-16 Directorate for Configuration Management's computerized Status Accounting system which showed, by ECP number, the average time lag in terms of months between the planned delivery date for the modified technical order and the actual delivery date. Only those modified technical orders resulting from COD ECPs with retrofit incorporated in Blocks 1, 5, 10, and 15 were included in the samples. Blocks 1 and 5 constituted the pre mini-block time frame. Blocks 10 and 15, which included mini-blocks 10A through 10D and 15A through 15K, constituted the post mini-block time frame.

The initial step was to determine whether or not the samples supported the assumptions necessary to use the parametric independent sample t-test (12:263). If equality of variances was found, then the t-test would be used. If not, the nonparametric Mann-Whitney Wilcoxon test would be used to analyze the data.

The second research hypothesis stated: the optimal mini-block size considering the retrofit labor costs and any associated impacts on the availability of the modified technical orders and support equipment would remain at two months. This was a quantitative study of the financial impact of four mini-block sizes as viewed from the impact on retrofit labor costs. The four mini-block sizes that were chosen are as follows: (1) the present span of two months/approximately 27 aircraft; (2) four months/ approximately 50 aircraft; (3) six months/approximately 75 aircraft; (4) eight months/approximately 100 aircraft (6:1). For these four mini-block sizes, an analysis was made of the financial impact, in terms of retrofit labor cost, caused by changing the present mini-block size of two months.

The basis for this analysis was the COD ECPs with retrofit that had been scheduled for production incorporation with the present mini-block schedule through Block 15K. From each COD ECP with retrofit, the total production and retrofit costs plus the manhours for retrofit were gathered. A projection of the total increased cost to General Dynamics and the Air Force was made showing the costs incurred by delaying production incorporation of the COD ECP with retrofit, thus having to retrofit additional aircraft. The list of COD ECPs with retrofit scheduled for production incorporation through Block 15K was provided by the F-16 Directorate for Configuration's F-16A/B Block Configuration (as of 1 March 1982) report (2).

The present block plan considered and designed by General Dynamics was used to develop the simulated block plan for the computation of retrofit labor cost changes based on retrofitting additional F-16 aircraft (4).

The following table (Table 1) shows the present block plan. The simulated block plan (Table 2), developed from the present block plan, was based on the assumption that the first mini-block under each mini-block size plan would contain the same number of COD ECPs with retrofit. The remainder of the COD ECPs with retrofit would be shifted into succeeding mini-blocks. This assumption was made in order to provide a starting point for the quantitative study.

Following the determination of how many COD ECPs with retrofit were shifted into the succeeding mini-blocks, Table 3, Effect of Mini-Block Length on Retrofit Labor Cost (Based on COD ECPs with Retrofit Effective in Production from Block 10A through Block 15K as of 1 March 1982), was developed. This table, located in Chapter IV, Data Findings and Analysis, shows the mini-block size considered, the number of COD ECPs with retrofit and the number shifted into the various mini-blocks, the total price of the COD ECPs with retrofit, and the increased cost, in terms of retrofit labor costs, from the present plan (4). The increased cost from the present plan section shows the percentage increase in cost from the present plan, the change in manhours to install the retrofit kits instead of incorporating the COD ECPs with retrofit during production, and the change in cost to install the retrofit kits as a result of the increased manhours expended. These costs

TABLE 1

PRESENT BLOCK PLAN, AS OF 1 MARCH 1982

BLOCKS:	10A	10B	10C	10D	15	15A	15B	15C	15D	15E	15F	15G	15H	15J	15K
Number of COD ECPs with Retrofit Authorized/ Proposed	8	8	7	2	2	3	2	2	0	2	0	0	1	0	0
Total Number of Aircraft Per Mini-Block	33	35	31	41	33	26	27	27	27	27	27	26	26	28	25

TABLE 2

SIMULATED BLOCK PLAN, AS OF 1 MARCH 1982

	SIMULATED REVISED BLOCKS:	10A	10B	15	15A	15B	15C	15D
4 MONTH PLAN	Number of COD ECPs with Retrofit Authorized/Proposed	8	15	4	5	2	2	1
	Total Number of A/C per Mini-Block	68	72	59	54	54	53	54
6 MONTH PLAN	Number of COD ECPs with Retrofit Authorized/Proposed	8	7	7	4	1	-	-
	Total Number of A/C per Mini-Block	99	100	81	80	79	-	-
8 MONTH PLAN	Number of COD ECPs with Retrofit Authorized/Proposed	8	9	7	3	-	-	-
	Total Number of A/C per Mini-Block	140	113	107	79	-	-	-

and manhours were determined by the number of aircraft that would require retrofit if the mini-block size increased.

The associated impacts on the areas of modified technical orders and support equipment were determined through interviews with F-16 SPO personnel. The interviews were conducted to discover what potential problems may surface if the mini-block size changed.

Summary

This research effort dealt with two hypotheses. The first hypothesis was concerned with determining whether the mean time between the planned delivery date for the modified technical orders and the actual delivery date has increased since the incorporation of the mini-block concept in the F-16 program. Depending upon whether the assumption of equality of variances holds true, either the parametric t-test for independent samples or the Mann-Whitney Wilcoxon nonparametric test for independent samples would be used to analyze the results.

The second hypothesis dealt with the optimal mini-block size considering the retrofit labor costs and any associated impacts in the areas of modified technical orders and support equipment. The impacts on modified technical orders and support equipment were determined through interviews with F-16 SPO personnel. The optimal mini-block size considering the retrofit labor costs was based on a quantitative study analyzing four mini-block sizes. For each of these mini-block sizes, an analysis was made of the financial impact caused by changing the present mini-block size of two months, and thus having to retrofit additional aircraft. The COD ECPs with retrofit scheduled for incorporation with the present mini-block schedule through Block 15K were the basis for this analysis. A projection of the increased cost to General Dynamics and the Air Force was made showing the additional retrofit labor costs incurred by delaying production incorporation of the COD ECPs with retrofit and thus retrofitting more F-16 aircraft.

CHAPTER IV

DATA FINDINGS AND ANALYSIS

The first research hypothesis stated that since the incorporation of the mini-block concept, the mean time between the planned delivery date (or need date) and the actual delivery date of the modified technical orders has decreased (level of significance equal to 0.05). If the t-test for independent samples were to be used to analyze the data, then several assumptions must have been met (12:255). The assumptions are

> (1) Both sampled populations have relative frequency distributions that are approximately normal. (2) The population variances are equal. (3) The samples are randomly and independently selected from the populations [12:255].

The assumption that both population variances are equal was tested using the F-test statistic (12:259-264). If the assumption held true, then the t-test for independent samples would have been used to analyze the data. If not, the Mann-Whitney Wilcoxon test for independent samples would have been used.

Thus, the following analysis was completed to determine whether equality of variances between the two populations existed. The null hypothesis stated that the population variances between the mean time for delivery of the modified technical orders for the pre mini-block time frame (σ_1^2) and the post mini-block time frame (σ_2^2) are equal. Mathematically, this was expressed as $\sigma_1^2 = \sigma_2^2$. The alternate hypothesis stated that the population variances between the mean time for delivery of the modified technical orders for the pre mini-block time frame (σ_1^2) and the post mini-block time frame (σ_2^2) are not equal. Mathematically, this was expressed as $\sigma_1^2 \neq \sigma_2^2$. The test statistic for this was the two-tail probability value for the F-test obtained from the computer printout (Appendix D). The level of significance value, α, was then used to determine the rejection region. The null hypothesis would be rejected if the two-tail probability value was less than the level of significance value. The level of significance value was previously set at 0.05. The null hypothesis was rejected since the two-tail probability value of .000 was less than 0.05. Therefore, the t-test for independent samples could not be used to analyze the data. The nonparametric Mann-Whitney Wilcoxon test for independent samples was used to analyze the technical order data.

The Mann-Whitney Wilcoxon two-sample independent test used to analyze the data was designed to determine whether the distributions of two independent samples are alike or different (9:22-23). The following assumptions must be made for the Mann-Whitney Wilcoxon two-sample independent test:

> . . . (1) the measurement scale for the samples must be at least ordinal; (2) the observations constitute independent random samples; (3) the random variables are continuous [10:165].

The following analysis was completed to determine whether the mean time between the planned delivery date for the modified technical orders and the actual delivery date was greater during the pre mini-block time frame than the post mini-block time frame.

The null hypothesis stated that the probability distributions corresponding to the mean time between the planned delivery dates for the modified technical orders and the actual delivery dates were identical for the pre mini-block and post mini-block time frames. The alternate hypothesis stated that the probability distribution for the mean time between the planned delivery dates for the modified technical orders and the actual delivery dates for the pre mini-block time frame lies above (to the right of) that for the post mini-block time frame. Since the level of significance was previously set at 0.05, the null hypothesis would be rejected if ZX_1R, the test statistic, was less than -1.96 (10:164). Due to the sample sizes, where n_1, the pre mini-block sample, was equal to 26 and n_2, the post mini-block sample, was equal to 16, the value of ZX_1R could not be read directly from any existing Mann-Whitney Wilcoxon two-independent-sample critical value tables (10:165). Therefore, the following formula was used to compute the value for ZX_1R:

$$ZX_1R = \frac{Tx - 0.5 - m(N+1)/2}{\sqrt{mn(N+1)/12}}$$

where Tx (the sum of the X ranks) is equal to 263.5. This was read directly from the computer results in Appendix D. The other values were m=16 (the post mini-block sample size), n=26 (the pre mini-block sample size), and N=42 (the sum of n+m). The test statistic, ZX_1R was computed to be -2.09. Since -2.09 is less than -1.96, the null hypothesis was rejected. The conclusion drawn was that the mean time between the planned delivery dates for the modified technical orders and the actual delivery dates for the pre mini-block time frame exceeded those for the post mini-block time frame.

Therefore, the mini-block concept in the F-16 SPO in the area of modified technical order availability did increase the supportability of the F-16 aircraft. This is not to state, however, that mini-blocks alone caused the decreased time between the planned and actual deliveries. The mini-block concept provided for the orderly incorporation of COD ECPs which helped the F-16 SPO and General Dynamics to focus the attention necessary to provide the modified technical orders along with the delivered aircraft, or as soon as possible.

The second hypothesis stated that the optimal mini-block size considering the retrofit labor costs and any associated impacts on the availability of the modified technical orders and support equipment would remain at two months. A quantitative study of the financial impact of four mini-block sizes was completed. Table 3 shows the study's results. Appendix E shows the exact computations for the total price in millions, the change in manhours to install retrofit kits, and the change in cost to install the retrofit kits.

As shown in Chapter III, Research Methodology, Table 2, Simulated Block Plan as of 1 March 1982, as the size of the mini-block expanded, so did the number of aircraft that must be retrofitted. However, the results of the quantitative study showed that the increased costs, due to the greater number of retrofit labor manhours expended, between the present mini-block size and the four month and six month mini-block were relatively small. The expansion in mini-block size from the present to eight months resulted in a price increase of 5.85 percent. This was a substantial increase when compared to the four and six month mini-block size increases of 2.37 percent and 2.42 percent, respectively. Thus, this quantitative study concluded that the increased cost due to more aircraft being retrofitted in the larger mini-blocks was not a valid argument for continuing with the two month mini-block

TABLE 3

EFFECT OF MINI-BLOCK LENGTH ON RETROFIT LABOR COST (BASED ON COD ECPs WITH RETROFIT EFFECTIVE IN PRODUCTION FROM BLOCK 10A THROUGH BLOCK 15K, AS OF 1 MARCH 1982)

			INCREASES FROM PRESENT TWO MONTH PLAN		
Mini-Block Length	Number of COD ECPs with Retrofit Total/Shifted	Total Price** in Millions	% Increase in Price	Δ in Manhours** to Install Retrofit Kits	Δ in Cost* to Install** Retrofit Kits
Present - 2 Months	37/0	5.469	-	-	-
4 Months	37/29	5.602	2.37%	4,421.0	$132,630
6 Months	37/29	5.605	2.42%	4,544.5	$136,335
8 Months	37/29	5.809	5.85%	11,342.0	$340,260

* Assumed to be $30 per manhour (4).

** Calculations in Appendix E.

and no longer considering the four month and six month mini-block sizes.

There is no concrete evidence, from a retrofit labor cost standpoint, that the optimal mini-block size is two months. Furthermore, there is no firm evidence that the mini-block size should not be increased. The mini-block concept has been shown to be useful in directing the attention of the F-16 SPO and General Dynamics to the necessity of providing the modified technical orders with the delivered aircraft. Larger mini-blocks would only increase the workload peaks in the areas of modified technical orders and support equipment but should not adversely affect the availability of those items to support the delivered F-16 aircraft (4; 15; 22). Thus, the issue, instead of being one of cost or supportability, has evolved into one addressing mini-block integrity (5:2). This is discussed in detail in Chapter V, Summary, Implications, and Analysis.

CHAPTER V

SUMMARY, IMPLICATIONS, AND ANALYSIS

Introduction

The continued proliferation of F-16 mini-blocks has resulted in concern over the multiple configurations of the F-16 aircraft (20:1). Supportability of the F-16 aircraft was, and still is, the key issue. From the operational point of view, the larger mini-blocks are better since more commonality within each wing would be obtained. From the F-16 SPO and General Dynamics point of view, the smaller two month mini-block size is best since it holds the integrity of the mini-block intact.

The research effort focused on (1) whether the mini-block concept had increased the availability of one area of support--modified technical orders, and (2) the effect of increased mini-block size on retrofit labor costs and any associated impacts in the areas of modified technical orders and support equipment.

Summary of Methodology and Findings

Using the Mann-Whitney Wilcoxon test for independent samples, the conclusion was drawn that the mean time between the planned delivery dates for the modified technical orders and the actual delivery dates had decreased during the post mini-block time frame. This confirmed the notion that the incorporation of the mini-block concept had provided for an orderly incorporation of COD ECPs and had focused the attention of the F-16 SPO and General Dynamics on providing this support as soon as possible, or along with the delivered F-16 aircraft.

The quantitative study results on the effect of mini-block length on retrofit labor cost neither supported nor rejected the research hypothesis that the optimal mini-block length should remain at two months. This held true even upon consideration of the possible impacts a larger mini-block would have in the areas of modified technical orders and support equipment. Thus, the conclusion of this study is that the cost difference, in terms of additional retrofit labor, for the production incorporation of COD ECPs with retrofit during the two month mini-block versus the incorporation of these same COD ECPs with retrofit during larger mini-blocks with additional retrofit labor dollars expended, is not a factor in determining optimal mini-block size.

Implications of Research

While the mini-block concept does increase the supportability of the delivered F-16 aircraft, looking at modified technical orders, in particular, the cost differential between production incorporation of the COD ECPs and the retrofit of additional F-16 aircraft, in terms of retrofit labor, is negligible. Thus, the issue becomes one of preserving the integrity of the mini-block concept. The concept was designed to provide for the orderly incorporation of COD ECPs thus controlling the configuration of the F-16 aircraft. If the mini-block size was increased, then the F-16 SPO and the user would either be forced to wait for changes or to compromise mini-block integrity by breaking in changes between blocks. Therefore, additional research needs to be completed to determine if the user would adhere to the mini-block concept or press the F-16 SPO and General Dynamics to break in changes between blocks.

Recommendations for Future Research

The recommendations for future research in the area of F-16 mini-blocks include the following:

1. Would alternative block plans, i.e. four and six month mini-blocks, increase costs since vendors have the right to make changes at the earliest possible time? Longer mini-blocks would force vendors to maintain the same configuration throughout the mini-block and then go back and retrofit all preceding F-16 aircraft components once a change is identified. This additional retrofit effort would be passed on to General Dymamics in terms of

increased price. General Dynamics, most likely, would pass these price increases on to the government.

2. What would be the cost impact (in terms of dollars) in the areas of modified technical orders, spares, and support equipment should the mini-block size be increased?

3. Would the user, Tactical Air Command (TAC), be willing to wait for non-safety related changes in the F-16 aircraft for possibly as long as twelve months in the case of a six month/75 aircraft mini-block, or would TAC push for changes to be made outside the block?

Concluding Observations

This research effort has shown the mini-block concept to be a valuable asset in incorporating many small COD ECPs on the F-16 aircraft in a timely, orderly manner. Hq TAC and Hq USAF are of the opinion that the mini-block size should be increased with the 27 to 30 aircraft mini-block plan as a fallback position used only when safety or overriding costs make immediate changes necessary (20; 21). The results of this study showed that the costs of increasing the mini-block size when considering retrofit labor are inconsequential. However, if the mini-block size is increased and the integrity of the mini-block concept not carefully preserved, this action may result in changes being made as soon as the material to do so becomes available. This is exactly what was occurring prior to the incorporation of the mini-block concept. The result then was the first 43 production F-16 aircraft being produced in nearly as many configurations (21:7). The result of increasing the mini-block size could be much less commonality in each wing instead of more and, accordingly, more retrofit effort becoming necessary. This would defeat the entire objective of the mini-block concept which is "to minimize retrofit type changes by predetermining the production break-in points within the major block and incorporate these changes at a common point in production [4]."

APPENDICES

APPENDIX A

TERMS/ACRONYMS/ABBREVIATIONS DEFINED

a/c--Aircraft.

Block--The major break-in points during production of the F-16 aircraft which are used to control major configuration changes with improvement ECPs. Production is broken up into blocks depending upon the scope of the changes to be introduced.

CCB--Configuration Change Board--A board composed of representatives from program/project functional areas such as engineering, configuration management, procurement, test and logistic support, production, training activities, and using/support organizations. This board approves or disapproves proposed engineering changes. The board issues a request/directive to implement its decision. In the case of the F-16 the board is known as the Multinational Configuration Control Board (MCCB) since it involves not only the United States but also Belgium, The Netherlands, Denmark and Norway.

COD--Correction of Deficiencies--A clause which may be used in a supply contract providing for correction of design deficiencies after delivery or acceptance of a product or weapon system. The contractor is held responsible for redesign efforts as well as materials and workmanship necessary to correct the defect. The government shares the cost.

Configuration Management--A discipline applying technical and administrative direction and surveillance to (1) identify and document the functional and physical characteristics of a configuration item, (2) control changes to those characteristics, and (3) record and report change processing and implementation status.

ECP--Engineering Change Proposal--The document which proposes system/equipment changes in accordance with applicable bulletins, regulations, and other directives. This document proposes design changes to an item, facility or part delivered or to be delivered which will require revision to the contract specifications or engineering drawings, or the documents referenced which are approved or authorized for applicable items under government contracts.

a. COD ECP--An ECP which relates tc correction of deficiencies in the item specifically. The government shares the cost with the contractor as set forth in the contract.

b. Improved ECP--This ECP is not related to correction of deficiencies. It relates only to enhancements to the item as proposed either by the contractor or the government.

Firm Fixed Price--A type of contract that provides for a price which is not subject to any adjustment by reason of the cost experience of the contractor in the performance of the contract.

Fokker--A company in The Netherlands with which General Dynamics (the prime contractor) subcontracted to coproduce the center fuselage and some other components of the F-16.

LCC--Life Cycle Cost--The total cost of an item or system over its full life. It includes the cost of development, production, ownership (operation, maintenance, support, etc.) and, where applicable, disposal.

Logistics--The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations deal with: (a) design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel; (b) movement evacuation and hospitalization of personnel; (c) acquisition or construction, maintenance, operation, and disposition of facilities; and (d) acquisition or furnishing of services.

Mini-block--A further division of major production blocks used by the F-16 SPO to insure adequate configuration management. The objective is to minimize retrofit changes by predetermining break-in points within major blocks.

MLSC--Measured Logistics Support Cost--In controlling life cycle costs the MLSC is used to determine whether the contractor is eligible for an award fee under the contract. In the case of the F-16 there is a 3500 flying hour verification test program which measures reliability, maintainability and unit price characteristics of first line units and associated support systems. If the MLSC associated with the CODs (MLSC-COD) is less than the Target Logistic Support Cost-COD (TLSC-COD) the contractor is eligible for payment of an award fee. However, if the MLSC-COD is greater than the TLSC-COD by 25 percent, the contractor is required to initiate actions to correct the demonstrated deficiency.

Retrofit--Retroactive Refit--A modification of a configuration item to incorporate changes made in later production of a similar type item.

Retrofit Kits--A kit of parts and/or tools required to modify a piece of inservice equipment.

SABCA--Societe Anomyme Belge de Constructions Aeronautiques--A Belgium subcontractor of General Dynamics which produces the wings for the F-16.

Spare--An individual part, subassembly, or assembly supplied for the maintenance or repair of systems or equipment.

Support Equipment--Includes all equipment required to perform the support function, except that which is an integral part of the mission equipment. It does include tools, test equipment, automatic test equipment, and related computer programs and software.

TLSC--Target Logistic Support Costs--A goal set forth in the contract for support costs allocable to noncontrolled first line units plus all systems and weapon systems level support costs including aircraft servicing and scheduled maintenance. The TLSC applies to initial and replacement spares, equipment maintenance and support equipment (system level and common to more than one first line unit).

Technical Orders--The official medium for disseminating technical information, instructions, and safety procedures pertaining to the operation, installation, maintenance and modification of Air Force equipment and materiel.

APPENDIX B

CORRECTION OF DEFICIENCY (COD) ENGINEERING CHANGE PROPOSALS (ECP) WITH RETROFIT USED IN THIS RESEARCH EFFORT

BLOCK 1

ECP	TITLE
061	Center Fuselage Bulkhead Fixes
125	Modify MT-4579(U) Base Mount
189	Improve Corrosion Protection-Gun Shock Mounts
204	JFS Exhaust Duct Insulation Blanket on Seal
241	Strengthen Horizontal Tail Support Bulkhead
269	Remove Restrictors from NLG, Extend/Retract Hydraulic Circuit
352	Update Fire Control Radar Transmitter and Antenna
412	Modify Fire Control Radar Control Panel

BLOCK 5

ECP	TITLE
063	Hydraulic Pump Support Bracket
087	Reduce FCNP Current
095	Cockpit Drains
111	Reduce Stress Around Door Cut-out
117	Wheel Speed Sensor Material
118	Brake Control Valve Piston Stop
121	SMS CIU Corrections (B only)
122	SMS SCP Corrections
127	Add Drain Hole to Gunport
128	Modify Canopy Lock Installation
137	Chaff Flare Sequencer Switch
140	Redesign Nose Landing Gear Door Final Fix

BLOCK 5--continued

ECP	TITLE
142	Include Three Position Anti-icing Switch
143	ECS Ram Air Ejection Logic
154	Change Finish on MLG Downlock Switch Actuator
162	Eliminate Water Entrapment
191	Reduce Stress Concentration
213	Manual Pitch Override
214	Modify the AIM-9L Launcher Umbilical Retractor
215	Revise Positive Locking Device (B only)
271	Include Missile Launcher Harness and Attach Bolt
304	Correct Timing of Flight Control Panel Circuitry
323	Replace Existing Missile Launch Support Assembly
353	Trim 16T77240 Cover
443	Install Teflon Cover on Shield
446	Modify HUD Pilot's Display Unit Video Protection Cord

BLOCK 10

MINI-BLOCK A

ECP	TITLE
408	Redesign ESS Controller and Harness and ESS Electronic Component Tester
435	Revise Electric Bonding of Main Generator and Aircraft Battery Grounds
478	Add Check Valves to Prevent External Tank Refueling Anomalies

BLOCK 10

MINI-BLOCK A--continued

ECP	TITLE
479	Revise Wiring to Engine Starting AMDL Controller
517	Modify Flight Control Servoactuator
534	Revise Finish Requirement for Halon Bottle Sight Glass
557	Replace Four Air Data Hoses Having Silicone Slewing
565	Correct Seat Data Recorder, Revise Electronic Computer Assembly Memory

MINI-BLOCK B

ECP	TITLE
444	Replace Engine Side Link Mount Bolt
490	Provide EEC Caution Light
499	Eliminate Connector Interference
514	Add Safety Wire Hole to Fuel Pylon Bracket
532	Change ECS Turbine Oil Sump
549	Marking of Emergency Power System Drains
607	Replace Four AN-924 Jam Nuts in Speedbrake Control Piping System
611	Modification of FCR Radar Rack

MINI-BLOCK C

ECP	TITLE
512	Add Drain Provisions to Aft End of Inlet Duct
521	Install Cap to Eliminate Moisture in Connectors
540	Replace Five Air Data Hoses with Hoses Having Internal Soring

BLOCK 10

MINI-BLOCK C--continued

ECP	TITLE
556	Modify SMS CIU to Correct Block 10 Software and Hardware Deficiencies
590	Revise Filter Retainer in C7903 Hydraulic Restrictor
648	Replace Helicoil Insert on AIM-9 Launcher
680	Install FLCS Power Connector Stowage Panel in Lieu of FLCS Power Test Panel

MINI-BLOCK D

ECP	TITLE
595	Reduce Flight Control Servoactuator Support Pin Installation
613	Redesign EPU Fuel Control Valve Armature to Preclude Corrosion

BLOCK 15

ECP	TITLE
655	Redesign 30-Gallon Tank Fuel/Air Disconnect to Eliminate Poppet Hanging and Spring Retainer Disengagement
697	Revise Connector Mounting Plates to Prevent Weapon Pylon-to-Wing Electrical Interface Interference

MINI-BLOCK A

ECP	TITLE
535	Add Drain Holes in Rudder Island to Protect Amplifier Detector
546	Brake System Circuit Improvement
574	Modify Redesigned Electronic Control for ESS

MINI-BLOCK B

ECP	TITLE
529	Modify Nuclear Store Indication
603	Modify Stores Control Panel--Eliminate Flickering Display Lamps

MINI-BLOCK C

ECP	TITLE
604	Revise Inboard Upper Loading Edge Flap Seal
612	Redesign Horizontal Stabilizer Retainer Nut

MINI-BLOCK E

ECP	TITLE
602	Replace Standard Headset Wiring with Magnetically Shielded Wiring
656	Provide Orifice to Return Bleed Flow From Fuel Flow Prop

MINI-BLOCK H

ECP	TITLE
640	Add Capacitor to Anti-collision Light Power Supply

APPENDIX C

LETTERS AND MESSAGES--SELECTED DOCUMENTATION OF THE F-16 MINI-BLOCK CONFIGURATION MANAGEMENT CONCEPT

REFERENCE NUMBER 15: QUOTED IN FULL

"REPLY TO
ATTN OF: [ASD/]YP

SUBJECT: F-16 Mini-Block Size

TO: Hq TAC/LG/DR

1. In June 1981 the F-16 SPO at TAC's request, initiated a study to determine the optimum size of mini-blocks. The goal was to maximize the size of the F-16 mini-blocks without creating off-setting supportability impacts to the program. The mini-block sizes included in the study were:

a. Current mini-block size of two months (approx 27 aircraft).

b. Mini-block size of four months (approx 50 aircraft).

c. Mini-block size of eight months (approx 100 aircraft).

2. In late June a meeting was held with TAC, SPO, Ogden and GD personnel to discuss study results. During this meeting, all parties agreed that the six and eight month mini-block options were not desirable. We also agreed with TAC's request to accomplish further investigation of the two versus four month options.

3. Completion of our investigation was necessarily delayed due to priority effort associated with Project Update III and Project Update III follow-on actions. Now that we have completed the investigation we feel that it is in the best overall interests of the program to continue with the current two month mini-block span. Increasing the mini-block size to four months could possibly result in more aircraft of a single configuration at a specific site. However, there is a very high probability that our mutual desire to periodically accelerate selected high priority changes would result in breaking in more changes between mini-blocks. This would result in compromising the entire mini-block concept. With very few exceptions, we have been successful in protecting the integrity of the current two month mini-blocks. Expanding mini-block size to four

months would also result in somewhat higher kit, labor and spares costs. In addition, there would be less flexibility to accommodate future necessary interface changes in MSIP I aircraft in a timely manner.

4. For the reasons identified above, I consider it prudent to continue the current two month mini-block concept.

signed/
GEORGE L. MONAHAN, Jr.
Brigadier General, USAF
System Program Director
Deputy for F-16"

REFERENCE NUMBER 20: QUOTED IN FULL

"R012035Z JUN 81
FM HQ TAC LANGLEY AFB VA//LG/DP//
TO HQ AFSC ANDREWS AFB MD//SD/SUG//

UNCLAS

SUBJ: F-16 BLOCK/MINI-BLOCK CONFIGURATION CONTROL CONCEPT

1. DURING THE EARLY PHASES OF THE F-16 PROGRAM, THE TAC STAFF AND THE SPO WORKED TOGETHER TO DEVELOP A PRODUCTION CONFIGURATION CONTROL CONCEPT. THIS JOINT EFFORT EVOLVED INTO THE MAJOR/MINI BLOCK CONCEPT THAT IS USED TODAY. OUR INTENT AT THAT TIME WAS FOR THE MAJOR BLOCK BREAK-INS TO CONTROL MAJOR CONFIGURATION CHANGES. THE MINI-BLOCKS WOULD PROVIDE FOR CONTROL AND TIMELY INCORPORATION OF LESSER IMPROVEMENTS, SUCH AS, CORRECTION OF DEFICIENCY CHANGES AND RELIABILITY, MAINTAINABILITY REVISIONS, ETC.

2. WHILE WE ARE ADHERING TO THE CONCEPT, IT SEEMS AS THOUGH THE INTENT OF THE MINI-BLOCKS HAS BEEN LOST. OUR ORIGINAL INTENT WAS FOR MINI-BLOCKS OF 90-100 AIRCRAFT. WE ARE NOW PROJECTING THAT THESE MINI-BLOCK SERIES FOR BLOCK 15 WILL BE LESS THAN 30 AIRCRAFT. THIS PROLIFERATION OF MINI-BLOCKS SEEMS TO EXCEED INTENT AND REQUIREMENTS. IT ADDS TO THE DIFFICULTY IN EQUIPPING NEW SQUADRONS OR IN REPLACING AIRCRAFT IN EXISTING SQUADRONS. TECHNICAL ORDERS, SPARES, AND SOMETIMES SE, ARE AFFECTED BY THE MINI-BLOCK EFFECTIVITIES. ALTHOUGH WE ARE CONTROLLING THE CONFIGURATION, THE ASSOCIATED CHANGES FREQUENTLY ARE NOT SIMULTANEOUSLY AVAILABLE.

3. WE ASK YOU TO TAKE THE INITIATIVE TO REVIEW THIS SITUATION. WE BELIEVE THAT THE MINI-BLOCKS SHOULD BE SIZED TO APPROXIMATELY 90 AIRCRAFT. WE RECOGNIZE THAT THE RETROFIT COSTS MUST BE CONSIDERED AND WEIGHED AGAINST SPARES, TECHNICAL ORDERS AND SUPPORT EQUIPMENT IMPACTS. THIS MAY OCCASIONALLY DELAY FOR A FEW MONTHS CHANGES WHICH WE NEED INCORPORATED. YET, FROM THE OPERATIONAL VIEWPOINT WE ENDORSE A MUCH LARGER MINI-BLOCK CONCEPT."

REFERENCE NUMBER 21: QUOTED IN FULL, PAGE SEVEN

"REPLY TO
ATTN OF: HQ USAF/LEY

SUBJECT: F-16 Mini-Block Sizing

TO: HQ AFSC/SD

1. The Mini-block approach to configuration management was devised after General Dynamics (GD) produced the first 43 production F-16s in nearly as many different configurations, creating a tremendous logistics support problem for our maintenance and supply technicians, item managers, the SPO, and for the contractors themselves. The Mini-block concept now in use calls for production phase-in of engineering changes every two months, or 30 F-16s at today's production rate (27 when Peace Vector deliveries begin in Mar 82), and has been very effective in controlling configuration incorporation. For the past several months we have been working with TAC to convince your staff and the F-16 SPO to enlarge the size of each F-16 production Mini-block. The efforts have been unsuccessful even though the volume of ECPs is steadily reducing as the F-16 matures. Now is the time to enlarge the size of the Mini-block so that the F-16s assigned to new locations will be of one, or at the most two, configurations. From a logistics perspective, such integrity is absolutely essential to our ability to support peacetime training and wartime sortie requirements.

2. The 27-30 aircraft Mini-block plan should be the fallback position to be used only when safety or overriding costs dictate that engineering changes be incorporated as soon as possible. As a matter of course, Mini-blocks need to be enlarged to at least four months of production (54 aircraft) or more whenever possible. Larger Mini-blocks will reduce logistics costs and also reduce the exposure of our maintenance technicians to potential errors which result in installing the wrong part in the wrong Mini-block aircraft. This happened at Hill AFB, Utah in May 81 when an EPU turbine oversped and disintegrated because the wrong EPU controller had been installed in the aircraft. Turbine disintegration and explosion caused extensive damage to the aircraft. Fortunately no personal injuries

occurred, but this incident serves to illustrate the potential for mishap when we have several differently configured aircraft in one particular location.

3. We need to act in a positive manner on this important initiative. I solicit your full support for enlarging the size of each F-16 Mini-block to at least four months of production while retaining the current plan as a fallback position. I would appreciate your response at an early date.

4. This letter has been coordinated with AF/RDP, XOQ, and PRP.

FOR THE CHIEF OF STAFF

signed/
EUGENE D. ROBBETT
Colonel, USAF
Deputy Director, Maintenance and Supply"

APPENDIX D

COMPUTER PROGRAMS AND RESULTS

Computer Program for Modified Technical Orders

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8SPSS*SPSS8
RUN NAME          MODIFIED TOS
PRINT BACK        CONTROL
VARIABLE LIST     C,P
INPUT FORMAT      FREEFIELD
INPUT MEDIUM      CARD
N OF CASES        UNKNOWN
T-TEST            GROUPS =C/VARIABLES=p
READ INPUT DATA
1,4.79
1,0.43
1,14.49
1,2.21
1,1.63
1,7.08
1,7.08
1,3.49
1,1.47
1,7.42
1,9.88
1,22.56
1,26.04
1,10.57
1,0.16
1,7.72
1,14.21
1,1.93
1,29.08
1,6.15
1,10.07
1,0.18
1,0.93
1,0.70
1,14.70
1,3.68
2,7.83
2,0.18
2,7.31
2,0.37
2,2.09
2,0.67
2,1.40
2,2.37
2,3.27
2,9.08
2,7.04
2,0.44
2,0.86
2,5.45
2,3.36
2,0.04
END INPUT DATA
*SELECT IF   (CEQ1)
NPAR TESTS   K-S(NORMAL)=P
*SELECT IF   (CEQ2)
NPAR TESTS   K-S(NORMAL)=P
NPAR TESTS   M-W=P BY C(1,2)
FINISH
EOF
```

(Note: In first column, a "1" indicates the pre mini-block time frame and a "2" indicates the post mini-block time frame. The second column shows the average delay in months between the planned and actual delivery dates.

Results

t-Test

Group 1 - C EQ 1. (pre mini-block)

Group 2 - C EQ 2. (post mini-block)

Variable	Number of Cases	F Value	2-Tail Prob.
Group 1	26	6.70	0.000--used to test for equality of variances
Group 2	16		

Mann-Whitney U-Wilcoxon Sum W Test

P
BY
C

C =	1.	C =	2.
Mean Rank	Number	Mean Rank	Number
24.60	26	16.47	16

U	W	Corrected for ties	
		Z	2-Tailed P
127.7	263.5 ↓ equal to Tx	-2.0852	0.0371

APPENDIX E

CALCULATIONS FOR TABLE 3, EFFECT OF MINI-BLOCK LENGTH ON RETROFIT LABOR COST (BASED ON CORRECTION OF DEFICIENCY (COD) ENGINEERING CHANGE PROPOSALS (ECP) WITH RETROFIT EFFECTIVE IN PRODUCTION FROM BLOCK 10A THROUGH BLOCK 15K, AS OF 1 MARCH 1982)

CALCULATIONS FOR TOTAL PRICE IN MILLIONS

MINI-BLOCK 10A

COD ECPS W/RETROFIT:	408	435	478	479	517	534	557	565
a. PRODUCTION COST ($)	N/A	14371	72747	9806	134580	N/A	22967	64028
b. RETROFIT COST ($)	10,000	17019	187911	29482	234594	5000	24888	69153
NUMBER OF MANHRS TO RETROFIT/AIRCRAFT	5.0	2.3	8.0	15.0	6.0	2.0	8.8	1.5
NUMBER OF A/C	33							
TOTAL COST $\Sigma(a+b)$	$896,546							
TOTAL MANHRS TO RETROFIT/AIRCRAFT	48.6/AIRCRAFT							

MINI-BLOCK 10B

COD ECPS W/RETROFIT:	444	490	499	514	532	549	607	611
a. PRODUCTION COST ($)	86450	54332	12372	13629	N/A	22742	17818	N/A
b. RETROFIT COST ($)	142334	46267	11465	31220	7312	21127	14993	N/A
NUMBER OF MANHRS TO RETROFIT/AIRCRAFT	6.5	13.2	2.7	1.0	3.7	1.5	10.0	1.0
NUMBER OF A/C	35							
TOTAL COST $\Sigma(a+b)$	$482,061							
TOTAL MANHRS TO RETROFIT/AIRCRAFT	39.6/AIRCRAFT							

MINI-BLOCK 10C

COD ECPS W/RETROFIT:	512	521	540	556	590	680	648
e. PRODUCTION COST ($)	13733	25501	16225	144210	41750	368127	20065
f. RETROFIT COST ($)	13846	20424	45909	187575	103406	250877	38115
NUMBER OF MANHRS TO RETROFIT/AIRCRAFT	1.0	0.5	3.2	1.2	1.2	1.0	2.0
NUMBER OF A/C	31						
TOTAL COST $\Sigma(e+f)$	$1,289,782						
TOTAL MANHRS TO RETROFIT/AIRCRAFT	10.1/AIRCRAFT						

MINI-BLOCK 10D			BLOCK 15		
COD ECPS W/RETROFIT:	595	613		697	655
g. PRODUCTION COST ($)	17391	38774	i.	N/A	N/A
h. RETROFIT COST ($)	27933	185408	j.	39547	74637
NUMBER OF MANHRS TO RETROFIT/AIRCRAFT	7.6	4.0		23	7.8
NUMBER OF A/C	41			33	
TOTAL COST $\Sigma(g+h)$	$269,506		$\Sigma(i+j)$	$114,184	
TOTAL MANHRS TO RETROFIT/AIRCRAFT	11.6/AIRCRAFT			30.8/AIRCRAFT	

MINI-BLOCK 15A				MINI-BLOCK 15B			MINI-BLOCK 15C		
COD ECPS W/RETROFIT:	535	546	574		529	603		604	612
k. PRODUCTION COST ($)	17291	159596	N/A	m.	96607	177888	o.	31254	51730
l. RETROFIT COST ($)	25115	266977	1559	n.	164973	373167	p.	209296	242664
NUMBER OF MANHRS TO RETROFIT/AIRCRAFT	2.0	66.6	4.5		1.2	2.0		2.0	8.0
NUMBER OF A/C	26								
TOTAL COST $\Sigma(k+l)$	$470,538			$\Sigma(m+n)$	$812,635		$\Sigma(o+p)$	$534,944	
TOTAL MANHRS TO RETROFIT/AIRCRAFT	73.1/AIRCRAFT				3.2/AIRCRAFT			10.0/AIRCRAFT	

MINI-BLOCK 15E				MINI-BLOCK 15H
COD ECPS W/RETROFIT:	602	656		640
q. PRODUCTION COST ($)	107208	20502	s.	28942
r. RETROFIT COST ($)	234902	121353	t.	85843
NUMBER OF MANHRS TO RETROFIT/AIRCRAFT	11.4			1.5
NUMBER OF A/C	27			26
TOTAL COST $\Sigma(q+r)$	$483,965		$\Sigma(s+t)$	$114,785
TOTAL MANHRS TO RETROFIT/AIRCRAFT	14.4/AIRCRAFT			1.5/AIRCRAFT

TOTAL PRICE IN MILLIONS FOR:

PRESENT 2 MONTH PLAN = $\Sigma[\Sigma(a+b) + \Sigma(c+d) + \Sigma(e+f) + \Sigma(g+h) + \Sigma(i+j) + \Sigma(k+l) + \Sigma(m+n) + \Sigma(o+p) + \Sigma(q+r) + \Sigma(s+t)] \cong$

\$5.469 million

4 MONTH PLAN = \$5.469 million + Δ in cost to install retrofit kits

= \$5.469 million + .132630

= \$5.602 million

6 MONTH PLAN = \$5.469 million + Δ in cost to install retrofit kits

= \$5.469 million + .136335

= \$5.605 million

8 MONTH PLAN = \$5.469 million + Δ in cost to install retrofit kits

= \$5.469 million + .340260

= \$5.809 million

CALCULATIONS FOR Δ IN MANHOURS TO INSTALL RETROFIT KITS FOR:

PRESENT 2 MONTH PLAN

AT END OF 10B MUST RETROFIT 10A	(10A) 33 A/C x 39.6 MANHRS = 1306.8 MANHRS
AT END OF 10C MUST RETROFIT 10B & 10A	(10B) 35 A/C x 10.1 MANHRS = 686.8 MANHRS (10A) 33 A/C x 10.1 MANHRS (or 68 A/C x 10.1 MANHRS)
AT END OF 10D MUST RETROFIT 10C, 10B, & 10A	(10C) 31 A/C x 11.6 MANHRS (10B) 35 A/C x 11.6 MANHRS = 1148.4 MANHRS (10A) 33 A/C x 11.6 MANHRS (or 99 A/C x 11.6 MANHRS)
AT END OF 15 MUST RETROFIT 10D, 10C, 10B, & 10A	140 A/C x 30.8 MANHRS = 4312.0 MANHRS
AT END OF 15A MUST RETROFIT	173 A/C x 73.1 MANHRS =12646.3 MANHRS
AT END OF 15B MUST RETROFIT	199 A/C x 3.2 MANHRS = 636.8 MANHRS
AT END OF 15C MUST RETROFIT	226 A/C x 10.0 MANHRS = 2260.0 MANHRS
AT END OF 15E MUST RETROFIT	280 A/C x 14.4 MANHRS = 4032.0 MANHRS
AT END OF 15H MUST RETROFIT	360 A/C x 1.5 MANHRS = 540.0 MANHRS

PRESENT NUMBER OF MANHRS NEEDED 27569.1

4 MONTH PLAN (FROM SIMULATED BLOCK PLAN, TABLE 2)

AT END OF 10B MUST RETROFIT	68 A/C x 10.1 MANHRS = 68 A/C x 39.6 MANHRS	3379.6 MANHRS
AT END OF 15 MUST RETROFIT	140 A/C x 11.6 MANHRS = 140 A/C x 30.8 MANHRS	5936.0 MANHRS
AT END OF 15A MUST RETROFIT	199 A/C x 73.1 MANHRS = 199 A/C x 3.2 MANHRS	15183.7 MANHRS
AT END OF 15B MUST RETROFIT	253 A/C x 10.0 MANHRS =	2530.0 MANHRS
AT END OF 15C MUST RETROFIT	307 A/C x 14.4 MANHRS =	4420.8 MANHRS
AT END OF 15D MUST RETROFIT	360 A/C x 1.5 MANHRS =	540.0 MANHRS
	NUMBER OF MANHRS NECESSARY TO RETROFIT UNDER 4 MONTH PLAN	31990.1 MANHRS
	Δ FROM 2 MONTH PLAN	4421.0 MANHRS
	COST Δ (ASSUMED AT $30/MANHOUR)(5)	$132,630

6 MONTH PLAN (FROM SIMULATED BLOCK PLAN, TABLE 2)

AT END OF 10B MUST RETROFIT	99 A/C x 39.6 MANHRS = 99 A/C x 10.1 MANHRS 99 A/C x 11.6 MANHRS	6068.7 MANHRS
AT END OF 15 MUST RETROFIT	199 A/C x 30.8 MANHRS = 199 A/C x 73.1 MANHRS 199 A/C x 3.2 MANHRS	21312.9 MANHRS
AT END OF 15A MUST RETROFIT	280 A/C x 10.0 MANHRS = 280 A/C x 14.4 MANHRS 280 A/C x 1.5 MANHRS	4732.0 MANHRS
	NUMBER OF MANHRS NECESSARY TO RETROFIT UNDER 6 MONTH PLAN	32113.6 MANHRS
	Δ FROM 2 MONTH PLAN	4544.5 MANHRS
	COST Δ	$136,335

8 MONTH PLAN (FROM SIMULATED BLOCK PLAN, TABLE 2)

AT END OF 10B MUST RETROFIT	140 A/C x 39.6 MANHRS = 140 A/C x 10.1 MANHRS 140 A/C x 11.6 MANHRS 140 A/C x 30.8 MANHRS	12894.0 MANHRS
AT END OF 15 MUST RETROFIT	253 A/C x 73.1 MANHRS = 253 A/C x 3.2 MANHRS 253 A/C x 10.0 MANHRS 253 A/C x 14.4 MANHRS	25477.1 MANHRS
AT END OF 15A MUST RETROFIT	360 A/C x 1.5 MANHRS =	540.0 MANHRS
	NUMBER OF MANHRS NECESSARY TO RETROFIT UNDER 8 MONTH PLAN	38911.1 MANHRS
	Δ FROM 2 MONTH PLAN	11342.0 MANHRS
	COST Δ	$340,260

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